

# Enabling political legitimacy and conceptual integration for climate change adaptation research within an agricultural bureaucracy: a systemic inquiry

Journal Item

# Enabling political legitimacy and conceptual integration for climate change adaptation research within an agricultural bureaucracy: A systemic inquiry

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**Abstract:** The value of using systems approaches, for situations framed as 'super wicked', is examined from the perspective of research managers and stakeholders in a state-based climate change adaptation (CCA) program (CliChAP) pre-2010 and polycentric drivers influencing the development of CCA research in Victoria, Australia are reflected on. Soft Systems Methodology (SSM) structured the inquiry beginning with a cultural analysis to generate a boundary critique of CCA research as a human activity system. We experienced the complexity of purpose with research practices pulling in different directions, reflected on the appropriateness of agricultural bureaucracies' historical management practices, and focused on means for joint articulations of purpose. Our analysis conceptualised CliChAP as a subsystem generating novelty in a wider system concerned with socio-ecological co-evolution. Constraining/enabling interactions dealing with political legitimacy and conceptual integration were observed as potential catalysts for innovation in research management practice towards better handling of uncertainty as a social process.

**Keywords:** wicked problems, research management, boundary critique, science-policy practice, socio-ecological co-evolution

## 1. Introduction

### *1.1 Climate change as a 'super wicked' science-policy practice issue*

The situation of bringing systemic understandings and practices to institutionalised agriculture can be characterized as one in which there are many interdependencies, complexity, uncertainty, controversy and multiple stakeholders (and thus multiple perspectives) – particularly on the nature of change, strategy, future directions and appropriate practices (Ison, Röling, & Watson, 2007; Ison, Collins, & Wallis, 2014). This is because there are contested, or unsurfaced, epistemological commitments and assumptions

and institutional barriers associated with the functioning of contemporary governance organisations, especially those of the state in a Westminster-related public or civil service, i.e., bureaucracy (Giddens, 2009; Ison, 2010; Jiggins, Blackmore, Ison & Röling, 2016). Complex matters of climate change challenge business-as-usual (BAU) thinking and practices within existing models of agricultural bureaucracy, partly because of their inability to deal with uncertainty as a social problem (Aldunce, Handmer, Beilin, & Howden, 2016; Jiggins, 2016).

Concurrent with similar inquiries into the future of agriculture in Australia and elsewhere (Australian Conservation Foundation [ACF], 2008; Land & Water Australia [LWA], 2008; IAASTD, 2008), the Australian Public Service Commission (APSC, 2007) looked at the issue of policy failure in response to long-term, intractable 'wicked problems' (Rittel & Webber, 1973) of which climate change, land degradation and river catchment managing can be regarded as examples. The advent of climate change has led some to broaden Rittel and Webber's (1973) distinctions between wicked and tame problems to include 'super-wicked problems' (Levin, Cashore, Bernstein, & Auld, 2012). Later the APSC's Commissioner Briggs observed that: "governments are facing new policy challenges, such as climate change, water scarcity, Indigenous welfare, and diseases linked strongly to lifestyle, problems which traditional policies and practices do not seem able to address effectively" (2009, Forward, para. 7). These problems are difficult to formulate and resolve as they have multiple causes interacting in complex ways that are not well understood. These authors, along with others who see an imperative within our current human circumstances of acknowledging the complex (Douthwaite, Kuby, & van de Fliert, 2003; Espinosa & Harnden, 2007; Walker, 2008; Roome & Louche, 2015), and choosing apposite situational framings such as 'wicked' or 'super wicked' (Levin Cashore, Bernstein, & Auld, 2012), also recognise the importance

of introducing and institutionalising systems thinking in practice (STiP), though this realisation is not new (Jantsch, 1972; Flood & Ulrich, 1990; Mulgan 1997; Checkland, 1999).

As Collins and Ison (2009) illustrate engaging with climate change research, and the distinctions between mitigation and adaptation, throw up challenges to how these concepts and their related practices are to be understood. It is one thing to name an agenda for innovation and change; the challenge is to purposefully create new practices and institutional forms that enable action that is transformative in relation to 'the wicked problem' or situation of concern (Hall, Sulaiman, Clarke, & Yoganand, 2013; Roome & Louche, 2016; Eppel, 2016). Problems as pervasive and insurmountable as climate change require some internal re-rationalisation that can help improve the performance of actions intended to address the situation (Randles & Laasch, 2016; Puusiten & Lehtimäki, 2016) by becoming sensitive to the systemic effects of planned actions and the systemic consequences of actions already undertaken or built into extant practices and institutions (i.e., norms, or 'rules of the game').

*1.2 Using Systemic Inquiry to form a "wicked problem" boundary critique*

Considerations of climate change are, or will be, pervasive in all that is done in the foreseeable future not just in relation to agriculture; climate change adaptation (CCA) will be of particular concern (Collins & Ison, 2009; Ison, 2010). Systemic inquiry (SI) (Checkland & Poulter, 2006) is an institutional form as is a project but, unlike a project, SI starts from a condition of admitting uncertainty and rejects the goal-seeking and timeframe imperatives that have come to characterise 'a project' (Allan, 2012). Inquiry is deeply embedded in systems scholarship, not just in terms of external observations but in reflection on cognitive (and social) processes of inquiry, For Churchman (1971) "inquiry" was a reflective process where thinking, doubting and learning were integral to inquiry practices; reflective learning is

learning about how we learn and knowing about how we know (Reichelt et al., 2016; Ison, 2010; Hammond, 1996). SI sits within the systems lineage of scholarship associated with inquiry, learning and pragmatism (Churchman 1971; Dewey 1916/2004; Checkland & Poulter 2006). Boundary critique is an approach used within systems scholarship that supports a shared understanding of the activities people are involved in, offering an opportunity to decide what is in and what lies outside of a system of interest or focus (van Bommel, Blackmore, Forster & de Vries, 2016). A SI enables the possibility of revisiting a boundary judgement in the light of new understanding to test prior assumptions used in generating a boundary critique (Checkland & Poulter, 2006, pp. 170-180).

In a climate-change world it is not knowable in advance as to how to make research practice more effective and to develop and employ systems thinking *and* science capabilities. In such a context SI makes sense. Our rational for employing a SI approach arose from acknowledging uncertainty at the start in relation to how to (i) introduce systems thinking in practice (STiP) into a conservative and complex bureaucracy and (ii) effectively use STiP approaches within CCA research (Ison, 2016). We also took seriously the claim by Ulrich (1996 p.17) that "we do not need the systems concept at all if we are not interested in handling systems boundaries critically". Concern about how, and by whom, systems boundaries are formulated is central to boundary critique; as Ulrich and Reynolds (2010) observe "the real value of boundary critique lies in its dialogical use to test other stakeholders reference systems" (p. 272).

The Ministry within which this research was conducted has been at the forefront of climate change research in the state of Victoria and Australia, building on and complementing other national and international efforts. The main programme of concern to the Ministry staff was

undertaken from 2006-2010 under the auspices of a state-based CCA program (CliChAP[1]) dealing with future agricultural systems research. In all over $2 million per annum was committed to CliChAP research with an additional $1 million in the first year. The Ministry also committed another $16 million to climate-related research over two years from 2008. CliChAP was designed as a program that would integrate knowledge across divisions and disciplines as a platform for bridging policy and scientific advice for the research and development of CCA.

Our research began when the CliChAP program was coming to the end of its first iteration and a review, prior to the running of a second round, was in prospect. This provided an opportune moment to open up reflection on the program activities and conceptualisations of its practitioners, as a means to improve working in the novel context of CCA research. It was also an opportunity to offer new, or alternative framings (Lakoff, 2010) e.g., CCA research as charting a trajectory of socio-ecological co-evolution. For this context, we adopt the meaning of co-evolution discussed by Puustinen and Lehtimäki (2016) of the evolution of one entity as partially dependent on the evolution of the other (p. 3). Our appreciation of CCA acknowledges an unfolding of social and natural environmental change implicating both sociocultural ways of knowing (epistemological) and biophysical reality (ontological) co-evolution. The CliChAP program entailed working between/with different areas of government involved in the research activities of the Ministry. This included environment and sustainability, planning and community development, and strategic policy development all of whom were likely to influence all that was done in the Ministry's portfolio as adaptation.

[1] This is not the actual name of the program but the one we use in this paper to discuss a boundary critique whilst endeavoring to protect the identity of participants and the organization. Where appropriate we use pseudonyms for the names of programs and ministries.

An initial phase of SI we undertook began in September 2009 and was drawn to a close in October 2010; it was also contextualised within a broader initiative, endorsed by the Ministry, concerned with the development and application of Systems Thinking and Systemic Science (Figure 1). We designed the SI so as to generate data and insights from the first iteration of the CliChAP research program and in relation to anticipated development of future CCA research. It was also designed in relation to how to introduce and build STiP as an organisational capability. Our intention was to develop an awareness of how members of the organisation participated in organisational routines and how they might be supported towards a better appreciation of CCA research practice using systems approaches.

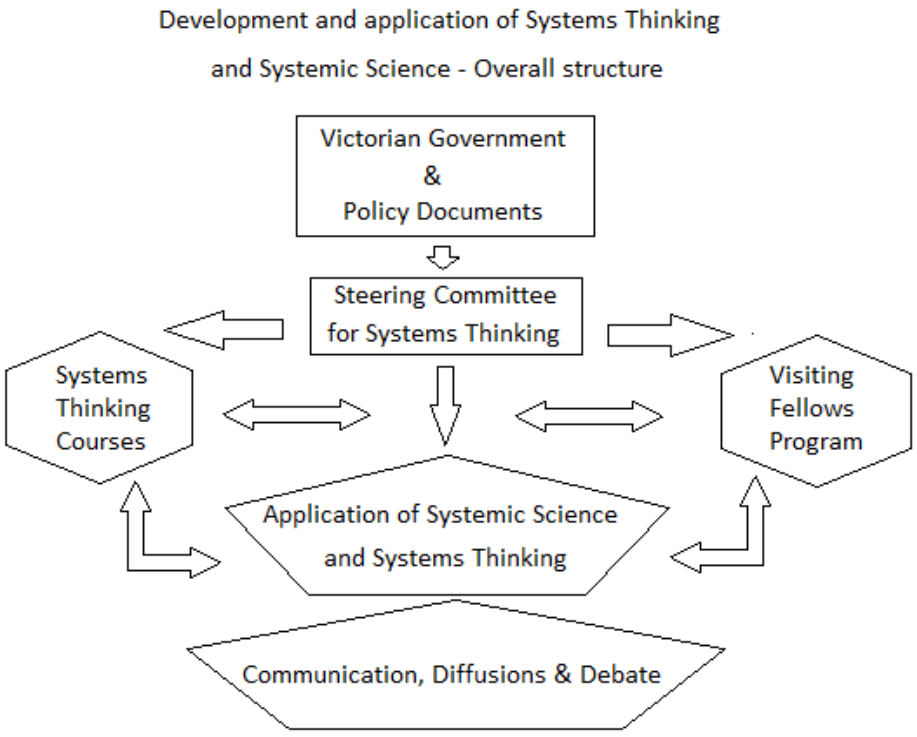


**Fig. 1** Schema outlining the main features of the Systems Thinking and Systemic Science initiative endorsed by the Ministry as conceptualised in early 2009

Soft Systems Methodology (SSM) was designed in response to concern about how an organisation might deal with a 'problematic' situation, i.e., a situation in which there is a recognised problem that needs attention but is not necessarily well-defined (Checkland & Scholes 1999). It situates the problem within a social and political context to better understand the practical implications of problem framing. In simple terms SSM is an "organised, flexible" approach to dealing with problem situations with a perceived need for improvement; to make situations more acceptable and "less full of tensions and unanswered questions" or uncertainty (Checkland & Poulter, 2006, p. 4). The approach of SSM is action oriented. It engages and utilises the perspectives of people involved in a problematic situation to give it more clarity and to find and articulate purpose as a means to improve the situation. From a management theory perspective it involves the articulating knowledge phase of deliberate learning (Romme et al., 2010). SSM can be used in organisations, by groups or individuals to improve the interactions between those involved in a situation even though they might be doing different things. It branches off from other systems traditions used in the 1950s and 1960s that had less focus on: the everyday contexts of problem situations; the importance of taking actions to address them; and the need for flexibility in approaches to using systems ideas (paraphrased from Checkland & Poulter, 2006, p. 4-6). Using SSM within our SI seemed an apt approach to formulating a boundary critique with our research participants.

This was not evaluative research (Vieira, O'Dwyer & Schneider, 2016), but an inquiry designed to learn about current circumstances in a way that could help build future capability and systemic innovation in CCA research in the Ministry. The research undertaken can be understood as beginning an 'experiment' in systemic, social system design (Metcalf, 2014); it

rested on a number of premises:

(i) climate change research is a new form of research practice;

(ii) the domain of climate change, especially CCA, is a situation characterised by uncertainty, complexity and surprise (Ison, Röling, & Watson, 2007);

(iii) traditional approaches to research practice, including traditional project management, may have limitations in this domain (e.g., Allan, 2012), and

(iv) STiP may have useful contributions to make to the Ministry's future climate change research practice (e.g., Wadsworth, 2012).

*1.3. Designing and reporting on a Systemic Inquiry*

Three inquiry strands were initiated as a means to elucidate the starting conditions that shaped our understanding of the extant use of systems approaches within the Ministry: (1) the perspectives of research division managers; (2) an interdepartmental research program dealing with climate change adaptation (CliChAP); and (3) operations of Communities of Practice (CoPs) in the Ministry. The first strand involved workshops and semi-structured interviews with research division managers who desired to make better use of systems approaches (as well as those holding critical perspectives on such approaches). In the second SI strand ethnographic methods of document analysis, semi-structured interviews and participant observation were used to triangulate (Seale, 1999, p. 475[2]) inquiry into CCA research using a suite of systems concepts and adapting SSM. The third strand conducted interviews with people involved in CoPs within the Ministry to elucidate possible criteria for the purposeful design of a Systems CoP (Iaquinto, Ison & Faggian, 2011; Ison, Blackmore, Collins, Holwell and Iaquinto, 2014). This paper reports the findings from the second strand

[2] Rather than use triangulation to affirm convergence of evidence typically used in sociological inquiry, Seale applies a concept of triangulation to offer different views to surface a critical engagement with the way a particular problem is framed or understood and to generate new insights to problem definition.

of inquiry (Figure 2).

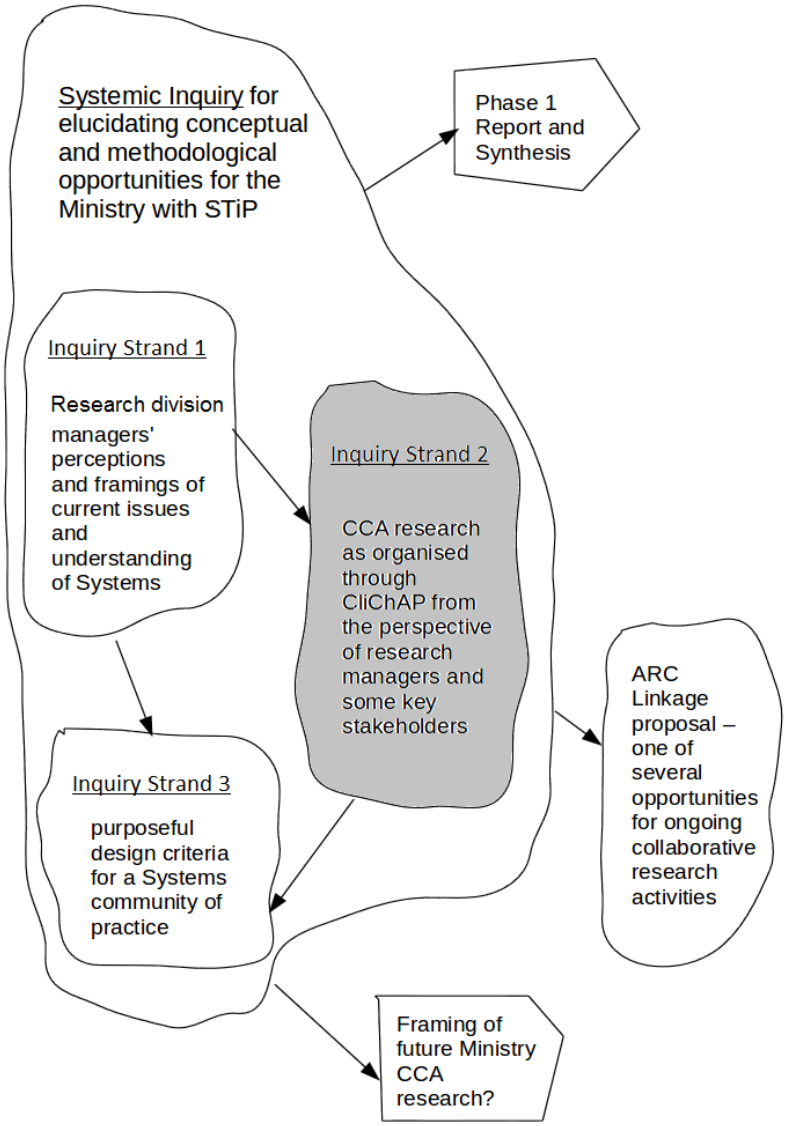


**Fig. 2** A conceptual model of the elements of a Systemic Inquiry (SI) undertaken as part of a Ministry and University collaboration addressing opportunities for using systems thinking (this paper deals with inquiry strand two into climate change adaptation (CCA) research)

In section two we explain and justify methods employed as elucidating desirable change through a joint appreciation of the 'system' in focus. We then describe our enactment of SI

modelled on i) a nested set of geopolitical discourses in policy documents addressing CCA; ii) a particular enactment of the Ministry's policy response and research program (CliChAP); and iii) the outcome of our process of engaging participants in SI as well as reflecting on our analysis and observations. In section four we introduce root definitions as systemic articulations of purpose, in section five we respond to our three key research questions (introduced below), and discuss participant's different articulations of purpose as pulling in different directions. In conclusion we explore strategic possibilities for using SI in future CCA research as a situation of socio-ecological co-evolution involving complexity, uncertainty and surprise to articulate a means for supporting the emergence of innovations in research management practice.

## 2. Methodology: preparing a systemic inquiry

### *2.1 Elucidating systemic appreciations of a 'wicked problem'*

Methodologically we framed CCA research as a human activity system pragmatically engaged in inquiry. We used triangulated methods to explore influential discourses of CCA research nesting the activities of CliChAP in a wider policy context (via document analysis), conceptualisations of CCA research as revealed through managers' and stakeholders perspectives of CliChAP (via semi-structured interviews), and local organisational culture of activities related to CCA research and policy development (via participant observations). Data collected for this inquiry strand is summarised in Table 1 (see also Figure 2). The rationale for collecting these data relates to choices made in our adaptation of SSM in which we modified the two streams model of SSM to more deeply explore the processes involved in articulating relevant systems (see section 2.3). Key questions were formulated to capture three elements of cultural analysis dealing with the 'problem', the 'social' and the 'political' situation (Checkland & Scholes, 1999) as:

1. How do participants construct the problem of climate change, what is the context in which they are motivated to respond to climate change?

2. How is climate change research rewarded, what are the significant roles for climate change researchers?

3. How can we analyse the relational dynamics as evident in the types of influence different interests and groups have over climate change research?

**Table 1:** Set of data collected for the inquiry strand through documents, interviews and participant observations

| | | Wider discourse | Strategic response | Internal ministry | External ministry | Non-government |
|---|---|---|---|---|---|---|
| Documents | International | 1 | | | | |
| | National | 1 | | | | |
| | State | 1 | | | | |
| | Ministry | | 3 | | | |
| Interviews | Research division | | | 6 | | |
| | Other division | | | 3 | | |
| | Environment | | | | 1 | |
| | Planning | | | | 1* | |
| | Policy & Strategy | | | | 1 | |
| Observations | Meeting | | | 1 | 1 | |
| | Workshop | | | 1 | | 2 |
| | Conference | | | 1 | 1 | 2 |
| | Training program | | | 1 | | |
| | Conversation | | | 28 | 10 | 9 |

*Interview conducted with two participants

The situation was approached using ethnographic methods of document analysis, semi-structured interviews and participant observations to ground inquiry in the actual practices

and perspectives of our participants (Hammersley & Atkinson, 1995). Three documents were selected for review, as recommended by our Ministry collaborators, to create a polycentric 'context' and sense of direction for CCA research nested within international, national and state discourses:

(i) Intergovernmental Panel on Climate Change [IPCC] Fourth Assessment Report Summary for Policy Makers (IPCC, 2007) referred to from here on as IPCC;

(ii) Land and Water Australia's National Climate Change Research Strategy for Primary Industries (LWA, 2008) referred to as CCRSPI; and

(iii) Victorian Government Climate Change Framework Green Paper (Victorian Government [VG], 2009b) referred to as CCFGP.

Within this nesting of CCA research policy drivers[3] we also examined three relevant Ministry strategies[4] (one for future agricultural systems and two iterations of a rolling four-year strategy for investment in agricultural research) as 'responses' to this wider context shaping the development of CliChAP. Thirteen participants (two in one interview[5]), were purposefully selected with our Ministry research collaborators to represent internal and external views of CCA research practice as it took place over a four year term of CliChAP. Participants' interviews captured six internal division (ID), three external division (ED) but internal Ministry, and three external Ministry (EM) perspectives to facilitate a multi-focal view of the situation. Participant observations were recorded whilst the first author was hosted by the division as a collaborative researcher, engaging with University and Ministry

[3] We acknowledge the choices made for this nesting of policy drivers. Another significant international document which potentially could have shaped CCA research in Australia is the 2008 Synthesis Report of the International Assessment of Agricultural Knowledge, Science and Technology for Development – the outcome of an international process in which Australia participated (although it did not endorse the final report).

[4] For purposes of anonymity we do not reference these strategies in this paper.

[5] We treat these two participants as one interview as their perspectives were similar, views expressed during interview reinforced each other and there was no attempt made by either participant to contradict or challenge each other.

research staff on a weekly basis throughout the research. Observations included reflective journaling of incidental conversations as well as attending meetings and events within the Ministry and other local policy-research interactions such as workshops and conferences occurring in Melbourne and other parts of Victoria.

### *2.2 Appreciating different conceptual models*

In situations best understood as 'super wicked' it is difficult to appreciate and articulate a stabilised 'real situation'; in this case so much was in an uncertain state including divergent leadership perspectives on whether or not human-induced climate change was 'real'. 'Conceptual models' presented during interviews and other interactions were used to reveal how various actors understood their situation. A conceptual model[6] is a cognitive framework that includes representations of tangible things or abstract ideas and relationships between them. We employed conceptual models of our own and sought to make apparent the conceptual models held by different participants as processes designed to have an effect on the real world situation. We sought to explore how conceptual models were revealing or concealing different aspects of the situation. For example, climate change was expected to impact on plant physiology through increasing/ decreasing parameters of temperature, carbon dioxide and water. By experimenting with these parameters better knowledge of plant responses to change could assist in understanding how to maintain or improve food qualities and productivity.

### *2.3 Adapting Checkland and Scholes' two-streams approach: Exploring 'relevant systems'*

[6] Conceptual model is use here as distinct from mental model used by Rook and Watson (2017), as conceptual model was the main construct of SSM used to conceive of 'relevant systems'. Mental models are more closely aligned with the work that people do in the ways they interact with their work environments. Conceptual models abstract away from work to articulate a purpose for activities that may differ from the actual activities. We address this tension by engaging with theory-in-use (mental models) versus espoused theory (conceptual models).

Checkland and Scholes (1999) two streams approach (Figure 3A) was adapted as a way of moving towards a structured debate with our participants about what were perceived to be relevant systems in real world situations dealing with CCA. Figure 3A illustrates our adaptation of the two streams model of a human activity system involving a real world situation and a group of people intending to improve the situation. As the would-be improvers, our research team engaged with the real world situation in the Ministry: 1) as a culture involving a problem situation, a social and a political context in one stream and 2) through a set of conceptual models of the real world situation generating 'relevant systems', or epistemological devices to understand and effect change, in another logic-based stream (Figure 3A). We did not know how relevant systems would be articulated under the set of governance challenges presented and so needed to explore this with our participants using ethnographic methods as represented in Figure 3B.

Furthermore, we were interested in what documents and people claimed to be important compared with what people were actually doing as a basis for framing future iterations of CliChAP. Our adaptation of SSM drew upon Argyris and Schön's (1974) contrast of 'espoused theory' versus 'theory-in-use' to support the development of a boundary critique for our system of interest, i.e., a climate change researching system (Figure 3B) with a set of relevant subsystems. This grounded and action oriented use of soft systems approaches complements recent simulation modelling from management theory that explores learning and change of organisational routines in response to dynamic environments (Romme et al., 2010).

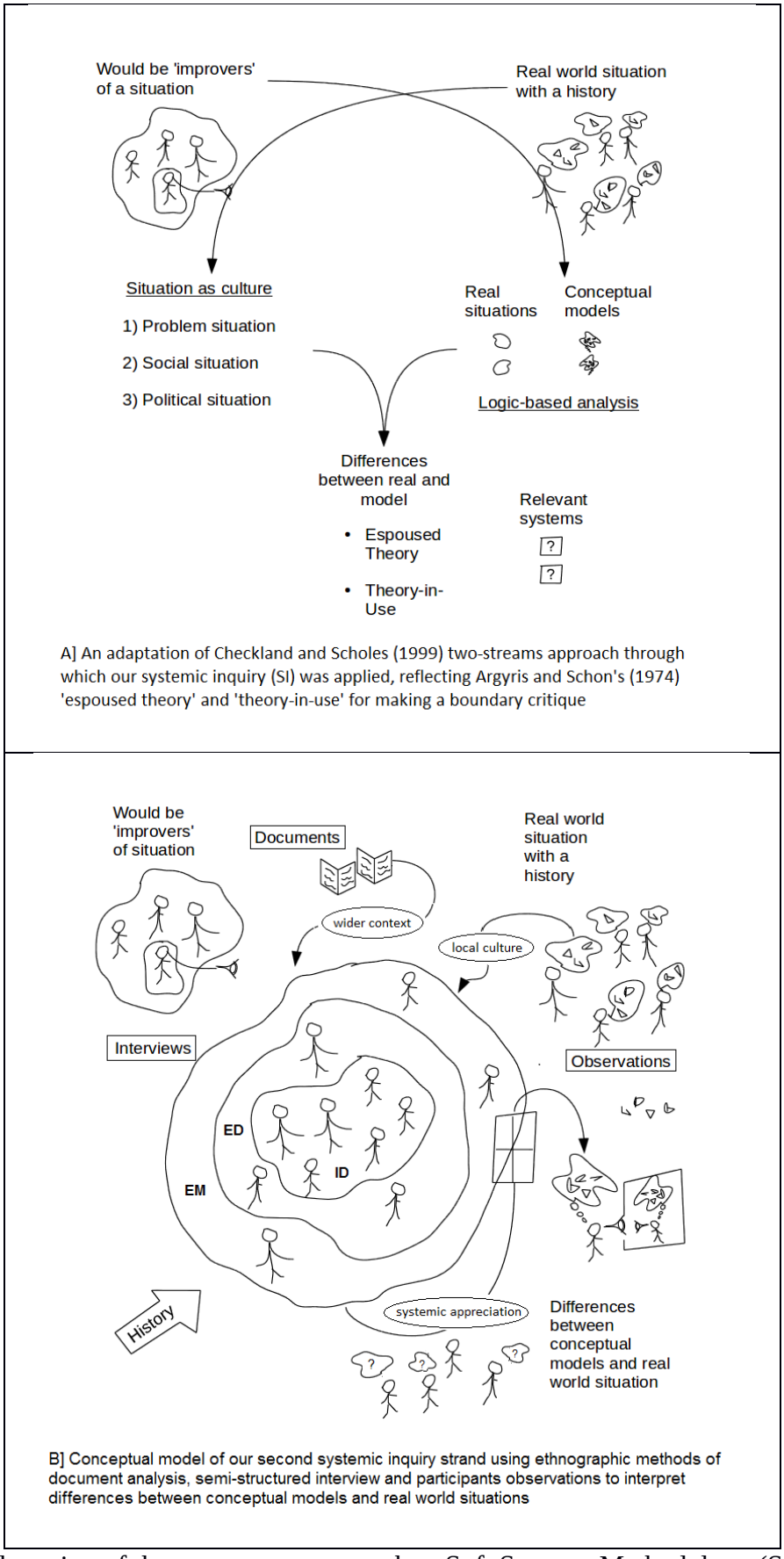


**Fig. 3** An adaptation of the two stream approach to Soft Systems Methodology (SSM)

enacted as a Systemic Inquiry (SI) for exploring cultural aspects of the situation including appreciation of espoused theory and theory-in-use (A), using ethnographic methods to interpret difference between conceptual models expressed by participants and as perceived by us (with our first author as the main observer, acting and checking interpretations with either of the other authors), and real world situations as perceived by us (B)

The nature of our SI was qualitative; it examined the actual practice of research management from the perspective of people involved supplemented by review of relevant policy documents and observations of practices within the research division. The data collected was not designed to be representative of all views but to provide a contextually valid account of the experiences and perspectives of people being researched (Patton, 2002; Tegegne, Penker & Wurzinger, 2016). Our inquiry sought to surface a range of perspectives exposing different experiences and views of CCA research practice so that grounds existed for inviting research participants to reflect on the issues our research surfaced as a means for appreciating and taking responsibility for appropriate boundary choices in future CCA research activities.

## 3. Methods: enacting a systemic inquiry

A contextual appreciation of Ministry-led CCA research as an inquiry system is first presented through brief discussion of the documents analysed (including policy drivers and Ministry response) and what the perspectives of research managers and stakeholders revealed. From this analysis, and following SSM, different root definitions of possible systems of interest (explained below) relevant to our participants' espoused activities were formulated.

### *3.1 Constructing root definitions: a system to do what?*

Root definitions (RDs) provide a basis for examining the underlying purpose, process and outcomes that shape a system of human activity/ activities (Checkland & Poulter, 2006). In this case they provided a means of exploring differences in what people do in CCA research that could then be used to inform a discussion about the purpose of CCA research and how different activities might be better aligned. A RD is used in SSM as a way of describing a possible, or potential, or implicit system of interest (Checkland & Poulter, 2006, p. 38-47). Creating a RD, or many RDs is something that can be done based on the outcomes of any structured engagement with a situation of concern, and is a way to make explicit one‘s thinking or the thinking of others in a systemic form. A root definition gives additional context to an activity when participants are asked, or research data are used, to describe a system to do something (P = what) by some means (Q = how) in order to achieve a certain outcome (R = why). Constructing root definitions is a technique that can be used to facilitate exchanges between diverse and possibly competing perspectives thus gaining accommodations between those with different interests.

*3.2 Geopolitically nested documents: a 'glocally' networked policy setting*

It was possible to elicit the main systemic drivers to what was then being enacted in CCA research from the sample of three documents (Table 1). While global responsibility was promulgated by the IPCC (e.g., changes in agricultural practice, policies and institutions to facilitate change, and appreciating constraints and opportunities), there were challenges in national and state implementation of this, suggesting the need for an opening of engagement where issues could be freely discussed and institutions developed in an environment of transparency and trust. At a national level in Australia, CCRSPI sought an understanding of the interrelationships between the actions of researchers, policy makers and producers while Victoria’s CCFGP sought greater awareness of the impacts of actions (of federal and other

states) on state economic and resource futures to enable contingency or flexibility in policy responses.

Our nesting of polycentric CCA discourses revealed systemic influences and relational dynamics between the local culture and wider context of CliChAP, including: i) the uncertainty of local climate change impacts and effective policy responses; ii) the need for innovative policy responses and better understanding of the interrelationships between resource management practices; and iii) the acceptance of greater risk and uncertainty with a need for more flexible policy approaches. What these documents did not discuss was the need for learning or being able to accommodate uncertainty as part of social practice and what implications that had for research practice and policy making.

*3.3 CliChAP's emergence through a whole-of-government approach to CCA*

CliChAP was an interdisciplinary interdepartmental program implemented under the Bracks Premiership in Victoria (1996-2007); it was a whole-of-government approach to dealing with climate change shaped by the Greenhouse Strategy and Sustainability Action Statement (VG, 2006). The Ministry's focus within CliChAP was ensuring that agriculture, forestry and fisheries could adapt to a changing climate in a way that sustained these industries into the future. CliChAP was implemented through alignment between different Ministries with the aim of integrating the state's emerging climate change policy framework (GPCCF) (VG, 2009b) as well as strategies for water policy (VG, 2007) and land and biodiversity (VG, 2009a). This was an ambitious interdepartmental approach to meet the, at times, competing demands of land, water and biodiversity conservation and production needs as well as internally competing land and water uses under conditions of climate change.

CliChAP presented a range of biological, social, policy, information technology and spatial science researchers within the division and some of its intra- and inter-departmental stakeholdings with a complex and difficult set of issues. It was a situation that required greater deliberation than was typically encountered in research management practice with higher levels of uncertainty making it difficult to decide on appropriate topics/ cause-effect relations or questions to explore that would benefit future development of agriculture amidst other primary industries and competing resource needs/ uses. Furthermore, the political situation when CliChAP entered its final year had changed significantly from the time of its implementation with leadership changes in federal and state governments that brought discursive and policy shifts in climate action.

*3.4 Engaging participants in Systemic Inquiry through interviews*

Interview participants (see Table 1) were asked ten interview questions that elicited 'descriptive' and 'reflective' responses (Figure 4). Our reflection on CliChAP with participants was intended to open up reflexive moments to facilitate innovative thinking and realise improvement in research management practice suited to the context in which researchers and stakeholders were motivated to respond to climate change.

| Descriptive questions | Reflective questions | How and where data used |
|---|---|---|
| Q1. What do you do and who are your main stakeholders? | Q2. How are you able to make a contribution to climate change knowledge? | Stakeholding and role used for creating a set of 'root definitions' of possible CCA researching systems |
| Q3. What kind of threat do you think climate change poses to Victorians? | Q4. What are different ways climate change is conceptualised? | Problem situation responding to key question one on CCA research construction and researcher motivations |
| Q5. How can and for whom will climate change research make a difference? | Q6. What conceptualisations of climate change are valued by stakeholders? | Social situation responding to key question two on research conceptualisation and rewarding by stakeholders |
| Q7. What does climate change research actually look like on the ground? | Q8. Is research activity linked up in any way, how? If no, why does it fail to be? | Political situation responding to key question three on relational dynamics and influences on CCA research |
| Q9. What barriers exist for research making a difference on the ground? | Q10. Is there anything else that you think is important to this discussion? | Yet to be dealt with in another paper focussing on overcoming barriers to transformative inquiry practice |

**Fig. 4** Two types of question, descriptive and reflective, asked during interview

Responses to these questions were explored for themes using Corbin and Strauss's (2008) methods of constant comparison between categories identified and people's actual interview comments. Questions one and two were used to generate descriptive and reflective thinking about participants' stakeholding and role and how that may or may not have led to credible and relevant knowledge on climate change. The analysis of these two questions was used to create a set of RDs of possible CCA research systems. Questions three to eight were analysed to both describe and reflect on the 'problem', the 'social' and the 'political' situation drawing out themes that could then also be related to the documents reviewed and participant observations. The final two of our interview questions, not dealt with here, are being taken up in another paper focussing on critical incidents for overcoming barriers to transformative research management practice to support CCA as a situation involving complexity, risk and

uncertainty.

*3.5 Incidental conversations and participant observations*

As a result of engagements over twelve months two main thematic areas of interest emerged for exploring the culture and practice of CCA research: i) gaining political legitimacy for research within the organisation; and ii) constrained conceptual integration of diverse program activities. It was concluded that these two issues held promise for personal reflection by researchers in a subsequent round of engagement in systemic co-inquiry. Our experiences suggested that exploring these two areas might enable greater institutional reflexivity by triggering ways of working more closely between policy, industry and community stakeholders (Bawden, 2005; Sposito, Faggian & Romeijn, 2013); or at least a discussion of personal motivations in relation to the motivations of others both inside and outside the research division (Barnett & Gregorowski, 2013; Reichelt et al., 2016). For helping realise this, we returned to our participants' descriptions and reflections on their role and contribution in CCA research (interview questions one and two) through which we felt participants were enacting political and social legitimacy of their activities (Figure 5).

## 4 Results of the first phase of SI

*4.1 Participants 'root definitions': A system to do what, how and why?*

The set of RDs shown in Figure 5 have been generated by us from analysis of content from interview questions one and two (Figure 4). Each RD depicts what the participants suggest as the dominant 'systems of interest' that the particular individual engaged with in research activities. Our formulation of participants' RDs reveals how research was pulling in different directions, from increasing capacity to act under conditions of uncertainty to improving the future quality of food and farm productivity. Others were concerned with appreciating policy

and the effects it has as well as concerns such as understanding climate change impacts and developing strategic options.

| What (P) | How (Q) | Why (R) |
|---|---|---|
| To provide decision support | …by narrowing the problem complexity | …to help farmers adapt to climate change |
| To understand the impact of climate change on plant physiology | …by experimenting with parameters of temperature, carbon dioxide and water | …to improve or maintain food qualities and productivity |
| To understand opportunities arising from change | …by recognising alternative farming systems inputs, e.g., for high protein diets | …to facilitate on-farm capability for adaptation |
| To extend climate knowledge through rural stakeholders | …by providing basic climate and emissions education | …to improve the literacy of farmers on climate change |
| To respond to changes in policy agenda | …by translating existing capability and to better target capability | …to meet varying stakeholder knowledge needs and interests |
| To increase the ability for new thinking and innovation | …by providing opportunities for new conversations | …to develop strategic options for adaptation (including mitigation) |
| To embed change into good government policy as something we have to respond to | …by recognising standards in the effects of actions taken | …to reflect and adapt policy according to evaluation of effects of action taken |
| To move beyond marginal adjustment stymied by doubt and uncertainty | …by realising efficiencies against a changing competitive environment and resource constraints | …to enable 'step change' or confidence in driving action towards transformation |
| To support the transition to a low carbon economy | …by recognising the socio-economic effects of changes in the environment | …to encourage innovative practice and new technologies in response to change |
| To create awareness of climate change issues and adaptation and mitigation options | …by engaging communities in discussion on issues around climate change | …to hear what the concerns of farmers are and feed that back into the design of R&D |
| To develop germplasm suited to new climatic conditions | …by identifying traits and management practices needed for changed environments | …to maintain production under changes climate conditions |
| To help stakeholders better understand implications and opportunities and feed their perspectives back into science and extension | …by engaging with and consulting peak industry bodies | …to encourage understanding of climate impacts and support industries in realising opportunities to increase profitability |

**Fig. 5** Constructed root definitions (RDs) of participants' 'system of interest' in CCA research based on responses to interview questions one and two (any sequence across the three columns should be read as 'a system to do P (what) by Q (how) because of R (why)')

A sense of coherency between such disparate areas of inquiry that could contribute to a whole of government approach to CCA was yet to emerge from participants. Participants RDs showed a high degree of variability with uncertainty playing a clear role in the purpose of research. Yet the areas in which research could tangibly change something that people could do or provide direction was lacking. We return to participants RDs at the end of our discussion as a basis for future engagement with participants.

However, first we take some steps to generate a boundary critique by comparing possible relevant systems with real world situations based on analysis of mental models (theories in use) versus conceptual models (espoused theories) of CCA research. Participants' interview responses to questions three to eight (Figure 4) are initially discussed within an understanding of the wider context and local culture generated through our triangulated ethnographic approach (Figure 3B). The discussion also points to how future research and research management practice could benefit from supporting co-inquiry using STiP to structure problem situations and deal with issues as they arise in processes of inquiry.

## 5. Key findings and discussion

### *5.1 Looking from the local situation on the wider context*

Figure 6 summarises interviewee responses, revealing diversity in descriptive and reflective perspectives of the problem, the social and the political situation. Responses are discussed so as to consider how research management practice enabled and constrained opportunities for: i) realising climate impacts; ii) opening up inquiry and iii) creating dialogue for innovations.

| DESCRIPTIVE | REFLECTIVE |
|---|---|
| The problem situation | |
| **Threat posed by climate change** | **Conceptualising climate change research** |
| Retaining productivity and food security | Better understanding of environmental interactions |
| Mental health and community well-being | Recognising socio-economic consequences |
| Climate uncertainty and less predictability | Improving capacity for shared responsibility |
| Competitiveness and business sustainability | Building local relevance of policy and science |
| Reactionary rather than anticipatory politics | Facilitating new research relationships |
| The social situation | |
| **Research making a difference** | **Stakeholders valuing of research** |
| Averting food insecurity | Focusing on ongoing production efficiencies |
| Adjusting to the effects of new environments | Understanding the complexity of the situation |
| Linking present and future choices | Facilitating a shared vision for investment |
| New technologies for engaging communities | Developing dynamic modelling capability |
| The political situation | |
| **CCA research on the ground** | **Linking up research activity** |
| Reframing projects as adaptation | Formal and informal research networks |
| Using evidence to change behaviour | Recognition of new relationships through research |
| Understanding the implications of forecasting | Rewarding feedback and collaboration |
| Contextualising and engaging stakeholders | Connecting disciplines, concepts, models |
| Biophysical interactions with environment | Organisational structures to support integration |

**Fig. 6** Summary of descriptive and reflective responses pertaining to three analyses (Figure 3A) of cultural aspects of the situation conceptualised by the two-stream approach

During analysis of participant responses it was apparent that the interview questions provided a basis for exploring participants' activities (or theories in use - mental models (Norman, 1983)) in reflection of various conceptual models of CCA research (espoused theories) (Argyris & Schön, 1974). Attention was given to capturing themes that represented the breadth of participants' perspectives in the responses to interview questions, and not just areas of commonality, as summarised in Figure 6. Some themes in the summary capture

responses from participants across all three groups (internal division, internal Ministry but external division and external Ministry), whilst others have only been shared by participants within the Ministry or across the division and other Ministries, although this cannot be assumed to capture all that participants thought about research and practice. These perspectives are now discussed in relation to the documents reviewed and participant observations to respond to the three key research questions (see Section 2 above). The summary in Figure 6 triangulates perspectives from across all three groups for critically discussing the boundary of CCA research as an inquiry system running across participants different areas of activity.

*5.2 Construction of climate change: a context for motivating response*

The IPCC *Synthesis Report for Policy Makers* posed the threat of "unmitigated climate change" as likely to "exceed the capacity of natural, managed and human systems to adapt" (IPPC, 2007, p. 65). Participants reinforced this problem framing as not only related to the ability to retain production and secure future food supply for the economic and social benefit of Victorians but included issues not traditionally addressed by agricultural bureaucracies such as mental health and community well-being. However, these complexities were difficult to convey in an environment where the 'three minute elevator speech' - a metaphor for having limited access to decision makers - was observed as the principle means of gaining influence within the Ministry. From this perspective the details of research activities collapsed into, at times, over-simplified explanations, leaving limited appreciation of the context in which knowledge was generated. Such simplifications of climate change research were contrary to dealing with the threat of climate uncertainty and less predictability, noted by participants within and external to the division as well as in other Ministries. Greater risk and uncertainty expressed in the green paper CCFGP (VG, 2009b) indicated a dynamic

decision making environment reflected as the contingency of state level choices to be made in relation to the effects of national policy (pp. 7-8). Some participants' descriptions reinforced this concern of climate change as a threat to competitiveness and business sustainability needing national-level leadership. However, the LWA document referenced concerns about science and practice with regard to primary industries coping with competition over land and water resources and their use continuing into the future (2008, p. 16). Thus sustainability is conceived not just as maintaining presence in a market place but better use of resources that does not diminish one's ability to adapt (Sposito, Faggian & Harmeijn, 2013; Bosomworth et al., 2017).

Participants' responses to how they were conceptualising climate change research reflected an opportunity for better understanding of environmental interactions and the socio-economic consequences of climate change. Internal Ministry participants also suggested that addressing the problem of climate change was improving capacity for sharing responsibility and that they themselves were contributing to building local relevance of policy and science. Non-division participants also indicated that they were facilitating new research relationships. However, following an initial program workshop offering constructive dialogue on cross-cutting issues in CliChAP, researchers were observed to fall back into their 'silos' or 'comfort zones'. Researchers and stakeholders seemed to be inspired by early dialogue but opportunities were not followed up. This suggests a need to explore narratives of climate change research practice to realise how institutional transformation was sidelined throughout the inquiry process. These and other institutional practices of failing to influence political action reinforced a concern expressed about the threat of reactionary rather than anticipatory politics. Such views indicated an inadequate consideration of the nature and scale of climate change impacts for realising appropriate policy responses. In 2007 the primary industries

strategy CCRSPI[7] encouraged scientists and policy stakeholders to engage with issues of climate change impact and adaptation at the national level. However during the implementation of CliChAP, in the years following, the continuation of earlier dialogue seemed difficult within the state Ministry. Initially a shift in participants' perspectives away from tendencies to isolate disciplinary areas within agricultural bureaucracies (including scientific research from policy advice) was apparent. However, efforts of integration were poorly maintained and may even have been constrained by institutional imperatives associated with project management to stay on task and therefore limit opportunities for further conversations. Some opportunities were noted for using locally embedded inquiry approaches, which supported the development of new research relationships but not from within the division. Opportunities that contextualised scientific and political dimensions of climate change impacts and adaptations were not as influential as they could have been in shaping research outcomes.

*5.3 Rewarding climate change research: significant roles for CCA research*

The IPCC emphasised the importance of sustainable development and how adaptation is now unavoidable, as evidenced by effects that are already being witnessed in hotter, drier conditions and more extreme weather events. In spite of differences in stakeholders' perspectives on whether or not the climate was changing or just displaying more variability, participants within the Ministry suggested that, socially, they were making a difference by helping to avert food insecurity. However, as noted, observations indicated there was little time for explaining issues or reflecting on more complex phenomena with state policy makers (outside of those drawn into some parts of the CliChAP program and research process).

[7] Land and Water Australia, the organization responsible for the development of the climate change research strategy for primary industries (CCRSPI) was disbanded in the year following this publication in a federal government restructure of land and water research.

Participants indicated that working more closely with farming operations and local organisations was leading to a higher level of appreciation for climate change impacts. Nevertheless, our observations within the organisation noted climate 'variability' and 'challenges' as replacing the stronger language of 'change' in the Ministry's description of research outcomes. It is possible that such language shifts were to avoid rather than challenge the political inconsistency around commitments to climate science witnessed in both state and federal governments in Australia at the time. This contrasted with an emphasis in the CCFGP on understanding designs for, and the effects of, an emissions trading scheme (ETS) as a significant policy response that remained unresolved and that was generating policy uncertainty (VG, 2009b, pp. 11-13).

On the other hand participants from within the division and the Ministry felt they were helping stakeholders in making adjustments to new environments by providing the scientific evidence that could support adaptations of current agricultural systems. Others, internal to the Ministry, felt that research was removing impediments to change by helping individuals realise opportunity outside of normal agricultural operations and providing an understanding of such impediments that could support policy development. Participants, notably from within the division, indicated that research was focusing on how actions in the present would impact future choices, opening up concern about future opportunity that could lead to/ inhibit innovation. In CCRSPI greater collaboration between researchers and decision makers was seen as part of a program of social activity including workshops, advocacy and championship to enable changes of practice. However the impetus of CCRSPI was not maintained at the national level as it was one of the last documents produced prior to LWA being disbanded. Nevertheless, participants external to the division felt that research was developing new techniques for engaging local and policy stakeholders in climate change adaptation as a

positive construction of interactions between researchers and communities.

CCRSPI had a focus on strengthening the partnership between research and industry as a means of encouraging cross-sectoral investment. Some participants reflected on key stakeholders within industry and the Ministry as continuing to value the contribution of research to production efficiencies. Yet they also reflected on how stakeholders were valuing an understanding of the complexity of the situation and developing capacity for appreciating the conditions through which innovation could be optimised. These evaluations were likely to include areas of managing risk and building resilience to market and natural environment dynamics. However, amongst the range of program areas observed, only one initiative in which sharing resources between researchers working in different areas was developed to acquire new research capability, in this case for meeting a gap in their expertise in regional economics. Traditionally in public sector research there has been a tendency to maintain disciplinary boundaries and prevent collaboration across divisions and departments. This has served as a means to keep research focused and possibly prevent deviation from what has historically been framed as a transactional approach to managing research timelines and milestone delivery (c.f., Eppel, 2016). However limited opportunities to innovate across program areas also left those involved in writing the final CliChAP report with the difficult challenge of bringing disparate program modules into a coherent whole. Furthermore, a focus on production efficiencies related to increasing profit margins seemed to circumvent a view that there were emerging environmental constraints on production such as resource competition. By comparison CCRSPI reinforced the IPCC concern for developing innovative policy approaches to managing natural resources as requiring new approaches to sustaining agricultural production amidst resource constraints (LWA, 2008, p. 16). In spite of limitations in developing conceptual integration, participants outside of the division saw research valued

through processes of facilitating a shared vision for investment and in developing a dynamic modelling capability that accommodated interactions between areas of scientific inquiry.

*5.4 Examining the relational dynamics: influence of different interests and groups*

The IPCC (2007) acknowledged uncertainty in: i) the details of how impacts will be felt in different locations; as well as ii) the effectiveness of different policy responses. However there was difficulty, in the changing Australian political environment, for researchers to move into a framing of climate change as underlying the design of research activities. Many existing projects not necessarily related to climate change impacts were simply 're-badged' to fit within the climate change adaptation program. Internal Ministry participants responded to the re-badging of existing projects with mixed feelings, on the one hand enabling the continuation of previously invested work, e.g., increasing efficiencies in production and integration of production and conservation methods for the marginal lands of upper catchments, and on the other as preventing response to emergent research needs. This was not inconsistent with CCRSPI that emphasised the importance of developing risk management approaches and information technologies to acting within a wider awareness of (social and natural) environmental constraints (LWA, 2008, pp. 24-25). Furthermore, participants indicated that research was being contextualised by engaging stakeholders directly in research activities and that CCA research was contributing positively to an understanding of biophysical interactions of agriculture with its ecological environment. Such understandings were likely to influence policy directions insofar as people felt empowered by the research. The CCFGP expressed a desire to set "strong, clear goals in responding to climate change", in "contributing to national efforts to reduce emissions" and "realising the [s]tate's ambitions for managing and adapting to the impacts of climate change" (VG, 2009b, p. 3). Participants recognised the importance of using evidence to change behaviour and of understanding the

political implications of forecasting, e.g., where future scenarios produced new political challenges that could influence policy directions. However the change in political direction of climate policy by end of the first iteration of CliChAP left this possibility unrealised and after some time earlier relationship developments undertaken were not taken up within the Ministry but able to continue under the initiative of researchers (Sposito, Faggian & Harmeijn, 2013).

Examples of planned adaptation in the agricultural sector envisaged by the IPCC covered: a) strategies such as the adjustment of planting dates and improved land management; b) reform of institutions, financial incentives and capacity building; and c) technological and financial constraints including access to new varieties, changes in growing seasons and revenues from new products (2007, p. 57). Such a suite of adaptation activities implicated a coordinated approach where adjustments in one area could support changes in another rather than lead to contradictory efforts. However, participant observations indicated a degree of 'scepticism' amongst researchers about working with other disciplines or areas of research, in addition to a lack of trust or confidence in engaging with areas outside of researchers' expertise, that seemed to hamper more open collaboration. Nevertheless participants reflected on the linking of research activity through informal and formal networks beyond the organisation's traditional research stakeholders including engagement of regional branches of government Ministries, service industries and community groups and recognised CCA research as contributing to the formation of new relationships. Some participants saw the importance of rewarding feedback and collaboration for making better links with new stakeholders as well as efforts of connecting research across different disciplines, concepts and models of adaptation. CCRSPI recommended additional areas for investment to drive innovative approaches to resource management and policy development including closer engagement

with the users of climate information to promote involvement in the processes of decision-making (LWA, 2008, p. 27). In this national strategy, dialogue was recognised as a valuable means to ensure activities and decisions of researchers, policy makers and primary producers were well aligned and interrelationships between resource management practices identified (LWA, 2008, p, 32). However internal Ministry participants indicated a lack of an organisational structure to support integration of research activities through dialogue.

Meanwhile the state government was concerned with taking advantage of the new opportunities emerging from the introduction of a carbon price at a federal level. The authors of the CCFGP were aware that setting a national target would lead to trade-offs in emissions reductions across its own industrial sectors and across states in which "a flexible policy tool like a trading scheme" is advantageous (VG, 2009b p. 7). It seems this was a critical development that circumvented all other activities, leaving the organisation with very limited alternatives to supporting CCA research without the certainty of an ETS.

The RD or systems of interest we have formulated from the research data show how diverse the espoused purposes of CCA research were within the Ministry. These 'system descriptions' are findings of the research in their own right, but they were also designed to facilitate on-going systemic co-inquiry (Foster, Collins, Ison et al., 2016). In a future engagement opportunity, such as a second cycle of CCA research, we would use the RDs in a process (i) of checking out their applicability with respondents and (ii) for using in the design of future research interactions. Emergent interests and stakeholdings could be used as a basis for defining and critically constructing a boundary for a systemic co-inquiry, e.g., for project development or for teasing out the strategic and operational implications of key staff implicitly enacting or managing such a diverse range of 'systems of interest'. For example, a

focus on resource constraints and considerations of making improvements to the efficiency or multiple use of resources could lead to new kinds of relationships and integration of research areas such as community, environmental and agricultural uses of water. An inquiry system that could accommodate this divergent set of purposes would work through a process of deciding together what tasks were to be performed by the system, alongside issues that impacted on the performance of such tasks.

In the conclusion we reflect on our approach and how STiP could be used to support future co-inquiry systems that appreciate and respond to the dynamics of socio-ecological co-evolution with a changing climate.

## 5 Concluding remarks

An ultimate aim was to develop a systemic framework to assess potential climate change impacts and adaptation actions in agriculture and forestry systems at regional and state-wide levels. This analysis was designed to invite consideration by research managers, researchers and stakeholders of what a systemic and adaptive[8] research governance framework for future CCA might look like. Our second inquiry strand (Figure 2) was initiated to create awareness of possible opportunities and to open up spaces for co-inquiry and how that could be supported or managed by dealing with climate impacts and adaptation uncertainty through social processes. Practices of research management in a Westminster-style bureaucracy require new modes of governance in which differences in research outcomes can be accommodated, including the unexpected, and realisation of opportunities to innovate can be achieved (Eppel, 2016; Clement & Standish, 2018). The uncertainty of climate policy

[8] By systemic we mean something that has an appreciation of how it operates as a whole system through its integrated or articulated parts performing a function that means more than simply a sum of its parts. By adaptive we mean something that is responsive to changes in its environment such that it also maintains a sense of its distinction from the environment in which it operates as a self-organising intelligence.

development experienced with changes in state and federal leadership at the time of our SI was not conducive to a second iteration of CCA research as funding models were put under pressure and CliChAP II failed to materialise in a way that participants expected. For some of those who had valued their relational investments in new research partnerships there was a need to shift their locus of research to facilitate the continuation of community-researcher co-inquiry (Sposito, Faggian & Harmeijn, 2013; c.f., Pretty & Chambers, 1993). Two of our authors relocated their research out of a centralised agricultural bureaucracy to a regional university in order to continue in their new stakeholder relationships built as a result of their CCA research activities both during and after the implementation of CliChAP.

Systems approaches are most useful when they are built into everyday practice, or where they are purposefully chosen to illuminate a situation of concern, or to chart a way forward when there is lack of clarity about purpose, or where direction is open to multiple interpretations or is contested (van Bommel, Blackmore, Forster & deVries, 2016; Rook &Watson, 2017). All too often it is assumed that because strategy is committed to text then it will be easy to follow and implement (Pelling et al., 2008; Agyris & Schön, 1974). Our engagement with the Ministry through this research shows that this is not the case in practice. In fact, one of the limitations faced by research managers within the CliChAP portfolio was the lack of a common conceptualisation of the CCA research situation that researchers could follow. This created particular demands on those responsible for 'joining-up' the research that was done and in articulating a coherent meta-narrative from the findings of the various components of CliChAP. Initiating a SI enabled us to open up and explore the usefulness of systems approaches for delving into participants' conceptual as well as mental models (Norman, 1983) through descriptive and reflective aspects of participation in CliChAP; therefore extending the capacity of SSM to more effectively deal with uncertainty as an intellectual and

a pragmatic concern (Argyris & Schön, 1974).

Co-evolution is the premise that organisations and their environments evolve in relation to each other (Porter, 2006; Puustinen & Lehitmaki, 2016). However, Porter (2006) notes that appreciation must be maintained that the evolution or state of being of an organisation (i.e., intelligence) must be distinct from the specific mechanisms of its becoming. This is the condition of emergence seen through interacting systems or the systemic effects of interactions and part of what Luhmann (1997) recognised as the inherent risk of uncertainty posed by overlapping self-referential systems. Our appreciation does not contradict this statement but includes reflection on the importance of a learning duality (Lave & Wenger, 1991) between the pathway to learning (participation) and the learning achieved (reification). Simulation of organisational learning models have demonstrated that learning capabilities in dynamic environments follow non-linear paths of articulated and codified knowledge development (Romme et al., 2010). The assumptions underpinning organisational evolutionary processes need to be exposed so that learning about the limitations of past rationalisations in relation to changed environments can be adjusted. Self-awareness or reflexivity in a systemic inquiry is important and not necessarily going to be captured by field experiments mimicking biophysical experiments that are not learning oriented (Delmas & Aragon-Correa, 2016).

From a pragmatists point of view knowing how we know and what shapes and limits inquiry is an important condition of recognising how an organisation impacts on and is impacted by its environment. Moreover as Tregidga, Kearins & Milne (2013) note assumptions embedded in documents, e.g., about ‘technological advancement, continuous improvement, and efficiencies’ (p. 102) may limit the possibilities for learning about the socio-ecological

conditions through which effective adaptations towards sustainable development will be achieved (also Pelling et al., 2008). Following codified or instructional processes are not necessarily going to produce an appropriate trajectory for learning in a system undergoing change. Constructivist approaches are better suited to such learning (Pretty & Chambers, 1993, p. 186) in which understanding emerges from the interactions between prior conceptions and the actions they inform, as an iterative social process of feedback and reconceptualization (Roome & Louche, 2015). Governance of unstable or less predictable environments requires an ability to recognise the emergence of socio-ecological sustainability in situ or place-based social and economic enterprise (Shrivastava & Kenelley, 2013). Such characteristics are not adequately captured through conservative agricultural bureaucracies because of their failure to embed learning within organisational routines, e.g., that focus on social and political aspects of knowledge articulations as well as their codifications (Romme et al., 2010).

Our SI has revealed possible systems of interest that could be drawn upon to facilitate the development of a systemic co-inquiry that opens up areas for learning about what adaptation looks like from different systems perspectives but also how adaptation can be achieved across diverse interacting research activities. Making the distinction between a system of inquiry and the effects of its actions is a reflexive process. The underlying premise and set of assumptions leading to the inquiry must be open to reconsideration. Appreciating the assumptions of our SI has also provided an opportunity for us as researchers to reflect on our own practice and conceptualisations of STiP. We used ethnographic research processes to articulate the problem, social and political situation by drawing on participants' descriptive and reflective accounts of research practice. Participants' descriptions indicated a transitional state of research practice in relation to the challenges of climate change and their reflections

as one of emergent relations that could be used to redefine the way research is practiced. In opening this inquiry our core concern became that research management practice was in need of revitalisation. Traditions of new public management within the bureaucracy that were task driven and process oriented failed to maintain efforts of research integration as an emergent and dynamic understanding throughout the duration of CliChAP. A subsequent inability to deal with CCA as a 'super wicked' problem constrained the generation of outcomes that could redirect science and policy through adoption of SI as a novelty for opening new trajectories in socio-ecological co-evolution.

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